IBMWeatherGen

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Georgia Tech
Open Source Program Office

Project Overview

Our primary objective was to enhance the IBMWeatherGen system by integrating advanced geostatistical methods and ML techniques to improve the variability and accuracy of weather generation This involves the integration of Quicksampling algorithms and exploration of innovative applications such as downscaling, extreme event prediction, and the integration of GANs and VAEs for semantic interpolation between weather fields.

Goals and Milestones

Semantic Interpolation Goals:

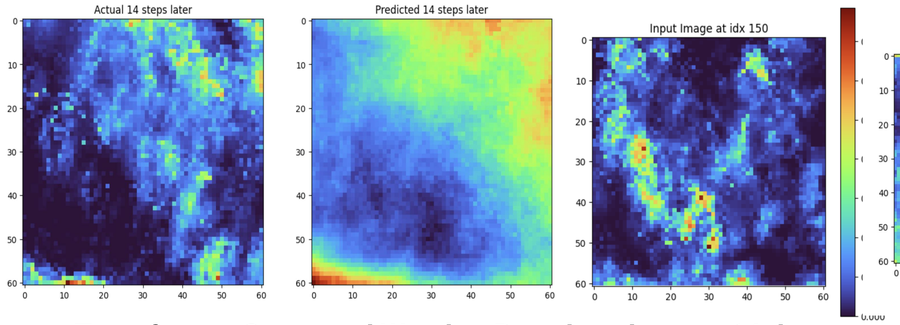
- Encode weather fields into small latent vectors which can be decoded to produce realistic images
- Study different methods of interpolation to create realistic paths of precipitation

Open Source Outcomes

Semantic Interpolation Outcomes:

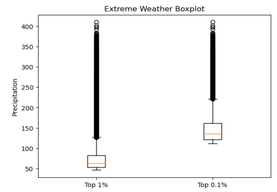
- Contributed to research of using VAEs and GANs to produce weather fields
- Contributed to research of effects of different interpolation method on latent vectors of weather fields
- Implemented GAN into IBMWeatherGen repository
- Try to use UNet and diffusion as the generative model to improving the outcome of VAE
- Fix the environment bugs given the update of Cpython and provides robust install method
- Provides Transfomer-based generative model condition on the past 14 days results and provides a valid results given very sparse data set
- Using the 0.1% extreme weather and Quick sampling to provides a more dense dataset

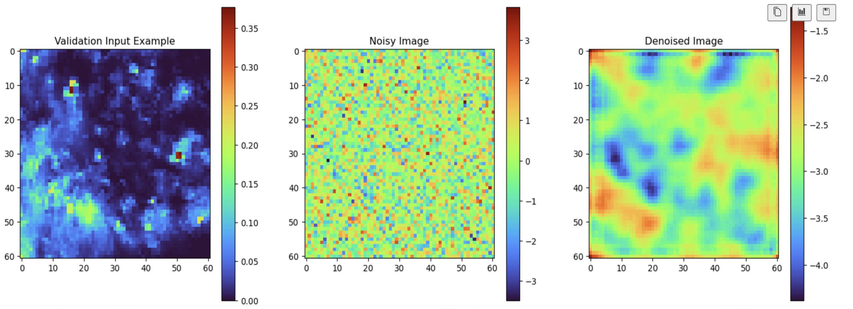
Highlights and Accomplishments – Conditional Generation, Diffusion and Quick sampling



- **Transformer Generated Weather Based on the past 14 days**.

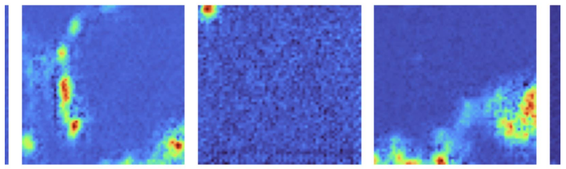
- **Quick sampling using the 0.1% Extreme Weather to generate new dense data**



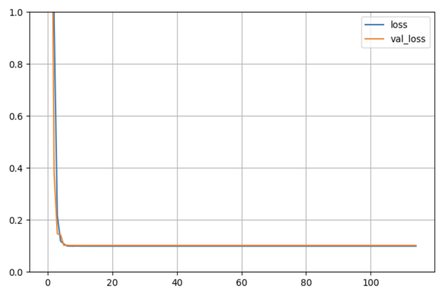


- **Unet Noise add and denoise (Diffusion) generated Weather**:
  - Encoder: Contains a series of convolutional and maximum pooling layers, each convolutional block consists of two layers of convolution and ReLU activation.
  - Each decoding block consists of one inverse convolutional layer and two convolutional layers.

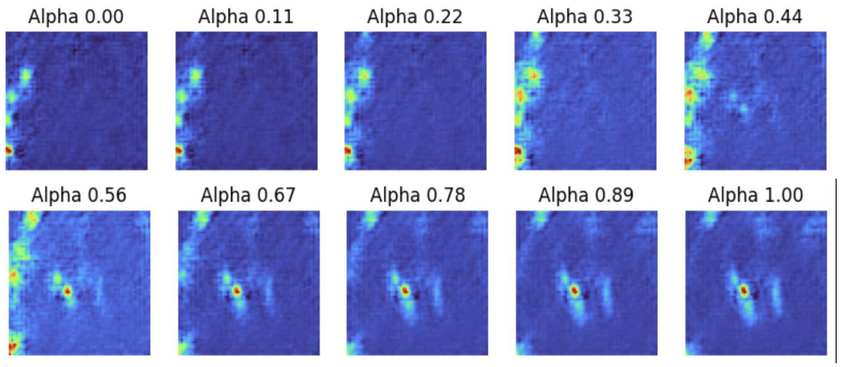
Highlights and Accomplishments – Semantic Interpolation and Field Generation



- Weather field images generated by GAN



- Used Generative Adversarial Networks to generate weather field images from a latent space
- Using SLERP (Spherical Linear Interpolation) to interpolate within the latent space and generate images, producing realistic weather paths



- Semantically Interpolated image

Future Work

- Improve images created by GANs to be more realistic
- Train GAN on hourly data to verify interpolation accuracy
- Try to have a better method to guide the diffusion model
- Improving the method that might help to generate more dense data for the weather.
- Find a better Method to provides a more robust way in diffusion to regenerate the data

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